UNITED STATES DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

Implementation of the Century Ecosystem Model for an Eroding Hillslope in Mississippi

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U.S. GEOLOGICAL SURVEY
OPEN-FILE REPORT 98-440

1998

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ABSTRACT

The objective of this study was to parameterize and implement the Century ecosystem model for an eroding, cultivated site near Senatobia, in Panola County, Mississippi, in order to understand the loss and replacement of soil organic carbon on an eroding cropland. The sites chosen for this study are located on highly eroded loess soils where USDA has conducted studies on rates of soil erosion. We used USDA sediment data from the study site and historical erosion estimates from the nearby area as model input for soil loss; in addition, inputs for parametization include particle-size data, climate data, and rainfall/runoff data that were collected and reported in companion papers. A cropping scenario was implemented to simulate a research site at the USDA watershed 2 at the Nelson Farm. Model output was compiled for comparison with data collected and reported in companion reports; interpretive comparisons are reported in [b]Harden et al, in press.

INTRODUCTION

Hillslope movement of soil carbon was studied as part of the Mississippi Basin Carbon Project (Sundquist et al 1998; Huntington et al. in prep; [ab]Harden et al in prep). High erosion rates on agricultural land result in major soil and carbon losses, some of which ends up in streams, rivers, reservoirs, and finally the ocean. A report from 1910 (Lowe 1910), describes massive soil losses due to poor management practices in the cotton fields of Mississippi.

At the soil surface, perturbation by conventional tillage results in a substantial loss of carbon to the atmosphere (Davidson and Ackerman 1993). Estimates of 20 to 50 percent of the original soil carbon have been reported for losses due to agricultural conversion of land (Houghton et al. 1983; Davidson and Ackerman 1993). In some areas, erosional losses result in an additional loss of carbon, but, the final outcome for this eroded carbon is less clear because of its removal from the hillslope. Depending upon the decomposition and burial of the eroded material, agricultural lands could be net sources or sinks (Lal et al. 1995; Stallard 1998) for terrestrial carbon ([b]Harden et al. in prep).

The purpose of this exercise was to estimate the soil and carbon losses which may have occurred at the Nelson Farm hillslope site over the historical cropping period, approximately 1870 to the present. The Century Ecosystem Model (Parton et al. 1988) was chosen because it allows the user to input various crop management practices and erosion amounts on a month by month basis. In the model, C, N, P, and S nutrients are modeled for the upper 20 cm of soil in various ecosystems, such as grasslands, forests, and agricultural fields. Carbon is partitioned into three pools of varying turnover times; som1c (fastest decomposition), som2c (slow or intermediate turnover), and som3c (passive or "recalcitrant" pool).

SITE DESCRIPTION

The sites for this study are located in northwestern Mississippi, in the Yazoo River basin (Huntington et al. in prep; [ab]Harden et al in prep). Soils at both sites are derived from Peoria Loess parent material, deposited roughly 12,000-20,000 years ago (Ruhe et al. 1967; Rodbell et al. 1997). The presence of a fragipan restricts the rooting depth of plants in these soils and slows the permeability of water (Rhoton & Tyler 1990).

The Nelson Farm site (Latitude, 34°33'50"; Longitude, 89°57'30") in the Senatobia, MS 1:24000 topographic quadrangle contains eroded Memphis silt loam (Typic Hapludalf) on the ridges and Grenada silt loam (Glossic Fragiudalfs) on the hillslopes (Huddleston 1967). Annual precipitation in nearby Tate County is 134 cm and annual average daily maximum and minimum temperatures are 23.9 and 10.6 °C, respectively (Huddleston 1967). The average depth to the fragipan on the eroded Nelson Farm site is approximately 40 cm, indicating a moderately eroded site (Rhoton & Tyler 1990). Control sites on forested ridgetops, however, have much thicker rooting depths, generally 80 to 100 cm ([a]Harden et al in prep.).

Forested ridgetop sites form the basis for our estimates of pre-cultivation soils. Before agriculture, most areas in Mississippi were forested with highly productive oak-hickory forests (Hilgard 1860). One set of Century model runs (low NPP) was initialized using a simulation of the nearby Goodwin Creek watershed (Latitude, 34°15'45", Longitude, 89°50'27"; Sardis SE, MS 1:24000 topographic quadrangle), which contained a climax, oak-hickory forest in 1996 when this study began. Based on tree cores taken from several post oak trees, the age of the forest is approximately 100 years old. There was some evidence for selective cutting; however, aerial photos from the 1930's show that all but the ridgetop was still a forest at that time. The depth to the fragipan is approximately 60 cm at the ridgetop and 50 cm in the slopes, indicating some erosion has likely occured early in the site history (Rhoton and Tyler 1990).

It is noteworthy that the Goodwin Creek forested watershed site (watershed 10; USDA) had much lower productivity than other oak-hickory forests in the region. Estimates of diameter-at-breast height (DBH) and total tree height (Dan Marion, USFS, personal commun) were tallied by the U.S. Forest Service for every tree with a DBH greater than 2.0 inches in two 405 m^2 plots in the Goodwin Creek. These measurements were used in conjunction with FIA (Forest Inventory Analysis) biomass reqression equations (data on file, Forest Inventory and Analysis Research Work Unit, Southern Research Station, Asheville, N.C.) to estimate aboveground tree biomass. A yearly increment for aboveground tree biomas was approximated by dividing the total tree biomass by the average age of the Goodwin Creek forest. The average yearly wood increment for the two plots, 297.57 $g/m^2/yr$, combined with a litter biomass measurement of 400 $g/m^2/yr$ gave an aboveground NPP value of 334.83 $gC/m^2/yr$. Aboveground NPP estimates from other climax, oak-hickory forests in Mississippi were 590.4 gC/m^2 (Hinesley 1978; Whittaker & Woodwell 1971; Lieth & Whittaker 1975; Olson 1969). Consistent with the low productivity, the soil organic matter at the Goodwin Creek site was notably low ([a]Harden et al in prep.). As a check on the Goodwin Creek site, other ridgetop soils at a local cemetery were evaluated and the depths to the fragipan were over 100 cm thick. Soils at this site contained about twice the amount of carbon as Goodwin Creek ([a]Harden et al. in prep) and may be more representative of the uneroded forests typical of the region in the late 1800's (Hilgard 1860). To account for the possibility that Goodwin Creek was atypical for the area, another set of model runs were done using the same Nelson Farm schedule files as used in the low NPP runs, but with iniital forest productivity about twice that found at Goodwin Creek (high NPP).

METHODS

Century model: Version 4.0 of the Century model is available for downloading from the internet at:

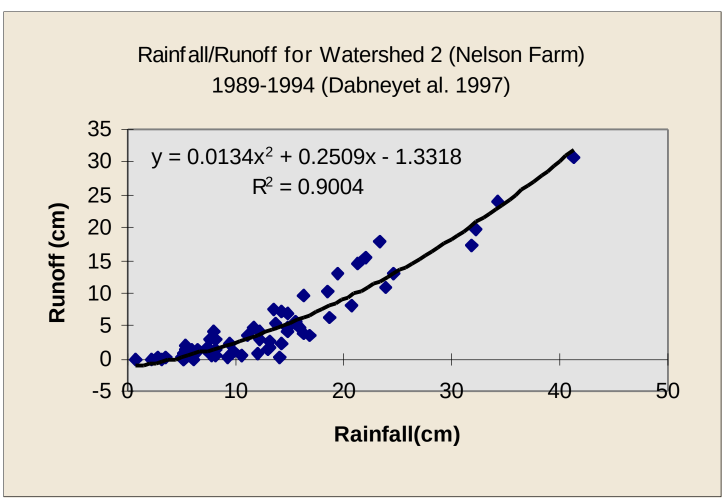
(ftp://ftp.nrel.colostate.edu/).

The Century model uses a site file, created by the user, to characterize the ecosystem to be modeled. In addition, the user must create a schedule file to designate the land-use changes, management, and time frame of the model run (see Appendix B). Weather statistics are automatically input into the site file once the user has formatted the data. Then, the user can indicate in the schedule file whether or not to use average or actual year by year weather data. Biome-specific "fix files," created by Century, contain fixed parameters relating to organic matter decomposition.

Site File: Soil texture was input into the model by designating the fractions of sand (0.0067), silt (0.8088), and clay (0.1843) for the intial control in the site file (Terry Fries, written communication, 1998). These specifications, along with a DRAIN factor of 0.5 (for moderately drained) and the soil temperature, regulate the decomposition rate, turnover times, and water holding capacity of the soil. The number of soil layers (NLAYPG and NLAYER) limit the water available for uptake by plants. The presence of a fragipan limited this depth to 45 cm in the eroded Nelson Farm site. Hence, the model specifications for NLAYPG and NLAYER are 3 for Nelson Farm starting in 1870.

Approximately 67 years of weather data from Holly Springs, Mississippi, were used to generate average monthly values of minimum and maximum air temperatures and precipitation. Stochastic weather was designated in the Century schedule for all years prior to 1930. Actual weather was used from 1930 to 1997.

Runoff data from watershed 2 was used to correct the Nelson Farm rainfall (see figure below).



Forested Control Modelling and Output: As a precursor to the Nelson Farm cropping simulation, we experimented with forested versions of Century to simulate the presettlement conditions. Although those files are not a part of this this report, a brief explanation will be given.

The schedule file for the forested control consisted of growing the forest for approximately 12,000 years. Although this estimate represents the minimum age of the Peoria loess, it was sufficient time for the model to grow a steady-state, climax forest (Ruhe et al. 1967; Rodbell et al. 1997). Erosion rates, designated in the Century schedule file, were obtained from actual data at Goodwin Creek Watershed no. 10. The yearly average sediment yield for 1982-1991 was 0.03 kg/m^2, which was divided by twelve for a monthly rate (unpublished data, USDA-ARS National Sedimentation Laboratory, Oxford, MS).

We ran the forest option for Century using the "Coweeta" file, a Longterm Ecological Research (LTER) site near Franklin, N.C., to characterize the nutrient content of the control forest in Mississippi. The SMXHW (southern mixed hardwood) forest option was also chosen, but the soil organic matter (SOM) output was not significantly different than the results obtained with the Coweeta forest option.

Because of its limiting effect on productivity, the amount of nitrogen was the most important factor determining the soil organic matter of the forest. In the site files of the forested controls, values chosen to represent atmospheric nitrogen inputs over the 12,000 year period of the model simulation were chosen based on the final, steady-state NPP (*for high NPP*, EPNFA(1)=0.06; EPNFA(2)=0; *for low NPP*, EPNFA(1)=0.4, EPNFA(2)=0). In the same way, values representing the effect of annual precipitation on non-symbiotic soil N fixation were also selected based on the final NPP (*for high NPP*, EPNFS(1)=(-)0.9; EPNFA(2)=0.015; *for low* NPP, EPNFS(1)=0, EPNFA(2)=0). Using the forest fix file (ffix.100) created by Century, a forest with an average NPP (548 gC/m^2) for oak-hickory was simulated using the high NPP values and a forest similar to Goodwin Creek was simulated using the lower nitrogen inputs (low NPP= 333 gC/m^2).

The modeled soil organic matter amounts from the simulated, forested control runs were:

low NPP (333 gC/m^2):

SOM1CI(1,1)=26, SOM1CI(2,1)=144.3, SOM2CI(1)=2070.71, AND SOM3CI=1128.59.

high NPP (548 gC/m^2):

SOM1CI(1,1)=47.8, SOM1CI(2,1)=266, SOM2CI(1)=3799, and SOM3CI=2394.

These parameters were inserted into the Nelson Farm site file as the initial soil carbon levels for the schedule files, Missmn and Missmx.

Nelson Farm Schedule Files: As discussed above, a Century schedule file is used to implement soil management practices such as erosion, harvests, and fertilization into the model. Outputs (from the forest model runs discussed above) were used to initialize the conditions for the Missmn and Missmx schedule files (Appendix A), which contain the historic cultivation and management of Nelson Farm.

The Century fix file used in conjunction with the cropping schedule files was gfix.100 (grassland parameters).

Atmospheric nitrogen inputs were slightly higher in the Nelson Farm simulation compared to the pre-1870, forested conditions. Since the Nelson Farm schedule file covered the time period of the Industrial Revolution, atmospheric nitrogen deposition was likely higher as a result of increasing industrial emissions. The model input, EPNFA(1), from the Nelson Farm site file, was reported as 0.34 gN/m^2 (EPNFA(2)=0), which coincides with atmospheric nitrogen deposition measured in the Coweeta Basin (Swank & Henderson 1976).

The cropping history of Nelson Farm is thought to be typical of agricultural land in Mississippi (see Table 1). An approximate cropping history was obtained for the years, 1870-1997, which coincides with historical accounts of land-use in the nearby area (John Massey, USDA, Mr. Nelson, personal commun.). The Nelson Farm site was originally purchased by the Nelson family in 1854. After clearing the woods, cotton was planted and plowed on the contour with mules. In this early period, cotton rows had wide spacings to allow room for workers and plant cover was not substantial enough to protect the soil. Federal conservation programs were implemented to combat soil erosion and in 1936, terraces were constructed at the Nelson Farm site. With the implementation of tractors in the 1960’s, the terraces were ripped out. During this time, the USDA-Agricultural Research Service purchased the land and began studying the impact of sediment on the landscape. Watershed 2, where data were collected and modeled, has remained in conventional tillage throughout its history. Sorghum, corn, and soybeans were grown between 1950 and 1980. After 1987, the only crop on Watershed 2 was conventional soybeans.

Sediment yield data at the Nelson Farm site were likely highest in the late 1800's, followed by a decline after about 1936 when soil management practices improved. The highest erosion occurred in the early historical period, 1870-1930, when continuous cotton agriculture exposed the bare soil by wide crop spacing and low plant production. A combination of factors, such as the topography and erodibility of the loess hills, and the lack of knowledge concerning soil loss, led to severe gullying of the land (Lowe 1910). Erosion diminished in the 1930's as a result of terracing, which was followed by practices such as higher plant density and fertilization, both of which reduced erosion (Doty and Dendy 1962). After 1953, we used specific cropping and management practices to estimate erosion rates based on the compilations of McGregor et al (1996). For instance, plots with grains and grass had notably lower erosion rates than row crops such as corn.

The erosion rates used in the schedule file were taken from studies on loess in the nearby area. Sediment yield data from gauged watersheds in Mississippi were used to compile a history of erosion rates for input to the Century model (Table 1). Actual erosion data were used in the last ten years (Dabney et al. 1997). Based on our estimates, a minimum (303 kg/m^2) and a maximum (831 kg/m^2) were calculated for the cumulative amount of erosion occurring over the historical period of Nelson Farm (Table 1). Given that sediment yield varies by numerous factors such as slope and rainfall intensity, it was thought that a high and a low would account for a range of uncertainty in historical erosion rates. As discussed in Harden et al, in prep, these cumulative soil losses were in agreement with estimates based on the difference between control and cultivated sites in the depth to the fragipan (Figure 1).

The Century schedule file requires monthly input for the erosion term, whereas most data in the literature were available in annual units. Spomer et al (1980) showed that the majority of sheet-rill erosion occurred during the months of May and June, when soils had been recently tilled. Therefore, in the Nelson Farm schedule file, 60% of the yearly erosion occurs during the month of tillage and the rest is averaged over the remaining 11 months.

As the soil erodes, Century re-adjusts the carbon pools of the 0-20 cm depth increment based on the carbon present in the lower horizons and fractional soil loss from the 0-20 cm depth increment. The adjustment is made to carbon storage of each som1, 2 and 3 pool of the (0-20 cm) depth, and losses to erosion are based on a sediment loss (rate) and carbon storage of the top 20 cm.

To adjust the 0-20 carbon contents as the soil erodes, the carbon derived from lower horizons is defined by the model input terms "lhzf1", lhzf2, and "lhzf3" (or more simply lhzf1,2,3) for lower horizon fractions of som1c, 2c, and 3c (discussed in more detail below). In Century, a term called "lhz1ci" (and lhz2ci, and 3ci) represents the carbon stored in a reservoir of lower horizons and is calculated as lhzf1*som1initial. (It should be noted that there are some options available for initializing SOM pools through the use of the ivauto term, but these options were not explored for this study.)

In Century, erosion is tracked as a fraction of soil to a stated depth (20 cm for our use). The term flost is calculated in monthly increments and in the spreadsheet is calculated in yearly increments in Century using the formula:

(Eq.) flost = g sediment eroded per m^2 / (g per m^3 bulk density * m depth)

Carbon storage in the lower horizon pool can be thought of as a finite pool that is depleted over time as erosion effectively moves the base of the 0-20 cm zone into deeper and deeper layers. The calculation for som1 in the lower horizon can be described as

(Eq.) lhz1Ci at time t = lhz1Ci(at time t-1) - (flost * lhz1Ci(time t – 1))

where lhz1Ci is initialized from lhzf1,2,3 and initial som1,2,3c.

Last, the amount of soil carbon being eroded is expressed as a product of erosion or sediment loss and soil organic matter of the topsoil:

(Eq.) scloss = somtc * flost,

where somtc is total soil carbon (gC m^2) and flost is the fraction of soil lost, expressed as a unitless number.

In order to determine prebomb ^{14}C values for the SOM1D, 2, and 3 pools, we used theoretical calculations and CENTURY output for pool sizes and turnover times. We also introduced a fourth pool (SOMloess) that represents the carbon content of the deep loess that was found to be a constant value below about 2m (0.13% carbon), and we re-combined SOM4 into SOM3 as though it had a turnover time of 406 years. The loess carbon ages with depth in a very consistent trend and appears to be the age of loess deposition based on ^{10}Be ages (Pavich, personal commun.). A theoretical calculation of ^{14}C values is described by the steady state equation in which inputs are balanced by decomposition in a mature forest; radiocarbon is lost by decomposition and radiodecay over the 11,000 years. From Century output, turnover times and pool sizes define the ^{14}C content of each pool at steady state for a soil that is 11,000 years old. The prebomb, $^{14}C/^{12}C$ values for SOM1D, SOM2, and SOM3 were estimated to be 1.00, 0.998, and 0.897 (0.952 for soil SOM3 and 0.80 for loess SOM3 in the uppermost 1m); the post-bomb values for 1996 were estimated to be 1.11, 1.21, and 0.917, respectively.

Values for lhzf1, 2, and 3 were determined from post-bomb estimates described above as compared with carbon storage and bulk ^{14}C data for uneroded control sites and simple theoretical models. Using a depth relationship for soil carbon as defined by Rosenbloom (1997) with the equation

$C(z) = Cs * (\exp^{z/z^*})$, where z* is a length scale for the decrease of C with depth and Cs is C content at the surface. (When z = z*, C at z equals 1/e of its surface value Cs.) We used Century output for the relative amounts of SOM1D, SOM2, and SOM3 in the surface 1m depth increment; the value of z* was changed until both carbon contents and FM were in agreement with data. Using z* values of 10, 20, and 50 for the SOM pools resulted in the best fit of the model to the C content and bulk ^{14}C data; these z* values resulted in lhzf terms of 0.1, 0.4, and 0.8.

RESULTS AND DISCUSSION

The historic pattern of soil organic matter at the Nelson Farm (Fig. 2) as modeled by Century is very similar to that modeled by Donigan et al, (1994). Amore detailed analysis of this pattern reveals the tremendous effect that certain crops and their management have on total SOM. Soil organic matter still declines with cotton production in 1930, despite the introduction of fertilizer; however, in 1954, the planting of soybean, a nitrogen-fixing legume, causes a marked increase in the total N in SOM (fig. 3). Another factor contributing to increases in SOM were higher residue amounts left on the ground. Increased knowledge in crop management led to the realization that "clean" farming was detrimental to the fertility of the soil (Doty and Dendy 1962). As a result, farmers began to leave more residues on the ground following harvest. This trend in harvesting was manipulated with the Century model and revealed in the output by increasing the average yearly surface C residue amounts by 10X for soybean compared to cotton. Although corn was planted instead of soybean in the years, 1968-80, an increase in total N in SOM is still seen due to fertilizer and the average yearly soil C residues for corn being roughly 6X higher than soybean.

Historical crop averages for Mississippi, obtained from the National Agriculture Statistics Service, and recent crop yields, 1988-97, measured at Nelson Farm by the USDA, were compared to output from Century (Fig. 4). Based on the close agreement, the modeled production seems quite typical of that at the Nelson Farm and Mississippi in general. The best agreement between the model and the actual crop data was obtained using the maximum erosion schedule and the low carbon forest similar to Goodwin Creek. Under this scenario, the model underestimated the yields by an average of 19%, except in the years, 1884-1930, when the model overestimated crop production by 66%. Initially following forest clearcut, the soil organic matter and associated N in the model may be higher than actual, resulting in an overestimation of crop production. Because of this, the cropping with initial conditions of the high carbon forest overestimated crop production in the early years, 1884-1930, by an average of 146%.

Contrary to an underestimation of the crop yields, Century overpredicted the final carbon numbers in the soil at Nelson Farm by 96% in the minimum erosion schedule and 71% in the maximum schedule (using the low carbon forest initialization). Likewise, the overestimation of final soil carbon using the high carbon forest was 139% and 65%, respectively. These numbers suggest that the maximum erosion schedule is a closer approximation of the erosion on the upper hillslope at the Nelson Farm and may even be an underestimate. In the "no erosion" scenario, which simulated the ridgetop at Nelson Farm, the model overestimated by only 3% using the low carbon forest, suggesting that the erosion plays a significant factor in the outcome. In addition, other factors such as the estimation of the number of tillage events could have a significant effect on the amount of soil carbon.

In addition to the uncertainty in estimating the erosion rates, other possible areas of error include miscalculation of the exact year of settlement at the Nelson Farm. It was known that the Nelson family purchased the land in 1854, however, the exact date of initial planting was not available. It was thought that initially following clearcut, the land might first be used for pasture. So, in the model, we allowed a 10-year period of low erosion before agriculture began in 1870.

Overall, the Century model appears to be reasonably well parameterized to represent the dynamics of the soil carbon at the Nelson Farm. For the carbon turnover times in the model, the maximum erosion schedule best represented our site on the steep hillslope at the Nelson Farm. It seems reasonable to assume that the maximum erosion schedule, Missmx, is more representative of the steeper slopes on loess material in Mississippi compared to the minimum erosion schedule (see Appendix A). Erosion estimates taken from the literature (Table 1) were not specific to hillslopes, but rather to entire watersheds, therefore they likely underestimate the erosion on the hillsope. In addition, the erosion data from Dabney et al.(1997) used in the final years, 1988-1994, were measured from a weir emplaced at the bottom of the watershed, and therefore likely underestimate erosion rates from the steeper hillslope. For example, above the weir there are slight depressional slopes where eroding sediment has collected (Dabney, personal communication).

The erosion schedules, Missmx and Missmn, are likely to be very high (by about 10X) for the Mississippi Basin, but very representative for our study of carbon and erosion on the steep hillslope (Stallard 1998).

TABLES

Table 1. Historic erosion rates from small watersheds in the Mississippi loess soils.

1st yr	last yr	N years	ann. eros. (kg/m2/yr) MINIMUM	Total Erosion kg/m2	ann. eros. (kg/m2/yr) MAXIMUM	Total Erosion kg/m2	Comments	References
1870	1871	13870	0.003	41.61	0.024	332.88	Forested watershed	1
1872	1882	11	0.072	0.792	0.17	1.87	Pasture following clearcut	2
1883	1929	47	3.8	178.6	**	578.05	Conventional till cotton	3
1930	1936	7	3.8	26.6	10.67	74.69	" "	
1937	1945	9	1.11	9.99	4.4	39.6	Terraces installed; cotton	4
1946	1946	1	8.59	8.59	8.59	8.59	Very high rainfall	
1947	1950	4	1.11	4.44	4.4	17.6	cotton	
1951	1953	3	0.85	8.64	0.85	2.55	Sorghum	5
1954	1967	14	1.95	27.3	4.4	61.6	Terraces ripped out; conv. till sybn	6
1968	1980	13	1.51	19.63	2.15	27.95	conv.till corn	7
1981	1981	1	0.4	0.4	0.76	0.76	winter wheat & soybean	8
1982	1983	2	0.24	0.48	0.24	0.48	wheat	8
1984	1987	4	0.24	0.96	0.24	0.96	Grass, no crop	8
1988	1988	1	1.74	1.74	1.74	1.74	conv. till sybn	9
1989	1989	1	4.4	4.4	4.4	4.4	conv. till sybn	9
1990	1990	1	1.02	1.02	1.02	1.02	conv. till sybn	9
1991	1991	1	3.26	3.26	3.26	3.26	conv. till sybn	9
1992	1992	1	1.9	1.9	1.9	1.9	Grass buffer strips installed; sybn	9
1993	1993	1	0.29	0.29	0.29	0.29	conv. till sybn	9
1994	1994	1	2.1	2.1	2.1	2.1	High rainfall; sybn	9
1995	1997	3	0.64	1.92	0.64	1.92	conv. till sybn	9
Total post-settlement soil loss kg/m2:				**303**		**831**		

1. ACTUAL DATA, unpublished, USDA/ARS National Sed. Lab., Oxford, MS
2.Carter et al, 1966; note that Dendy for lower delta cotton w/.2%slope found 1-2kgm-2yr
3. H.G. Meginnis (1930); McGregor et al.--poster
4. one high rain year; see 1994 record, Doty and Dendy (1962), McGregor et al. (1969)
5. McGregor & Mutchler (1992)
6. McGregor & Mutchler (1983); McGregor et al. (1969)
7. Mutchler & Greer (1984)
8. McGregor et al. (1975)
9. ACTUAL DATA, Dabney et al. (1997)

***10.67 kg/m2 in 1st, 3rd, and 4th years, 17.05 kg/m2 in 2nd years*

Table 2. Summary of Century Schedule File Events for the Nelson Farm

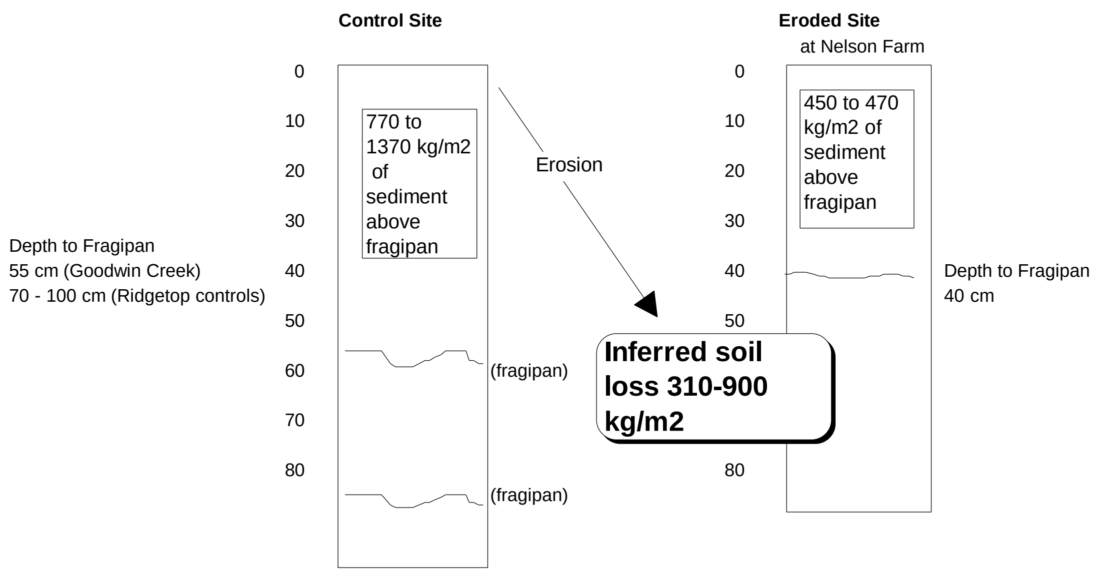
YEARS	CROP/S	CULTIVATIONS	HARVEST (% abvgrnd residue removed)	FERTILIZER	WEATHER	COMMENTS
1871-1882	GGCP (grass-clover-pasture)	animal tillage (1 yr. only)	none		stochastic	pasture following clearcut
1883-1929	COT (cotton)-	animal tillage (3)	GS (9) 50% removal	none	stochastic	
1930-36	COT (cotton)	animal tillage (3)	GS (10) 50% removal	N3 (4,5,6) 3 gN/m^2 PS2 (4,5,6) 250 kg/ha (superphosphate)	actual	
1937-45	COT (cotton)	animal tillage (3)	GS (10) 50% removal	N3 (4,5) 3 gN/m^2 PS2 (4,5) 250 kg/ha (superphosphate)	actual	
1946-50	COT (cotton)	animal tillage (3)	GS (10) 50% removal)	(same as above)	actual	
1951-53	SORG (sorghum)	plowing (3)	H (11) hay, 75% removal	none	actual	
1954-67	SYBN (soybean)	plowing (4)	G (10) 0% removal	A90 (6,7) automatic prod. at 90% max PS2 (5) 250 kg/ha (superphosphate)	actual	
1968-80	C-HI (corn)	plowing (5) ROW cultivation (6,7)	GS (10) 50% removal	MAX (5,6,7) max plant nutrient conc.	actual	
1981	SYBN (soybean) W3 (wheat-3)	plowing (4,9)	G (8) 0% removal	N3 (10) 3 gN/m^2 PS2 (4) 250 kg/ha superphosphate	actual	
1982	W3 (wheat-3)	plowing (8)	H(6) 75%removal	N3 (9) 3gN/m^2	actual	
1983	W3 (wheat-3)	plowing (7)	H(6) 75% removal	none	actual	
1984-86	G3 (grass)		none	none	actual	
1987	G3 (grass) W3 (wheat-3)	herbicide (7) cultivator (10) plowing (10) row-cultivator (11)	none	none	actual	FIRE Event (7) --hot burned plant growth
1988	SYBN (soybean)	mowed (3) plowed (3) row-cultivator (5) cultivator (7)	G (11) 0%removal	PS2 (6) 250 kg/ha superphosphate	actual	
1989	SYBN (soybean)	plowed (5) herbicide (5) cultivator (6,7)	G (10) 0% removal	PS2 (5) 250 kg/ha superphosphate	actual	
1990	SYBN (soybean)	herbicide (4,5) plowing (4,5) cultivator (6,7)	G (10) 0% removal	PS2 (6) 250 kg/ha superphosphate	actual	
1991	SYBN (soybean)	herbicide (5) plowing (5) sweeping (5) cultivator (6)	G (10) 0% removal	PS2 (7)250 kg/ha superphosphate	actual	
1992	SYBN (soybean)	herbicide (4, 6) plowing (4,5) cultivator (6) sweeping (5)	G (10) 0% removal	PS2 (6) 250 kg/ha superphosphate	actual	
1993	SYBN (soybean)	plowing (4,5) cultivator (6)	G (10) 0% removal	A90 (5,6,7) automatic production at 90% max	actual	
1994	SYBN (soybean)	plowing (3,5) herbicide (5) cultivator (6)	G (10) 0% removal	A90 (4,5,6) automatic production at 90% max	actual	
1995-97	SYBN (soybean)	plowing (3,4) cultivator (6) row-cultivator (5)	G (10) 0% removal	A90 (5,6,7) automatic production at 90% max	actual	

NOTE: numbers in parantheses denote the month in which event occurs

FIGURES

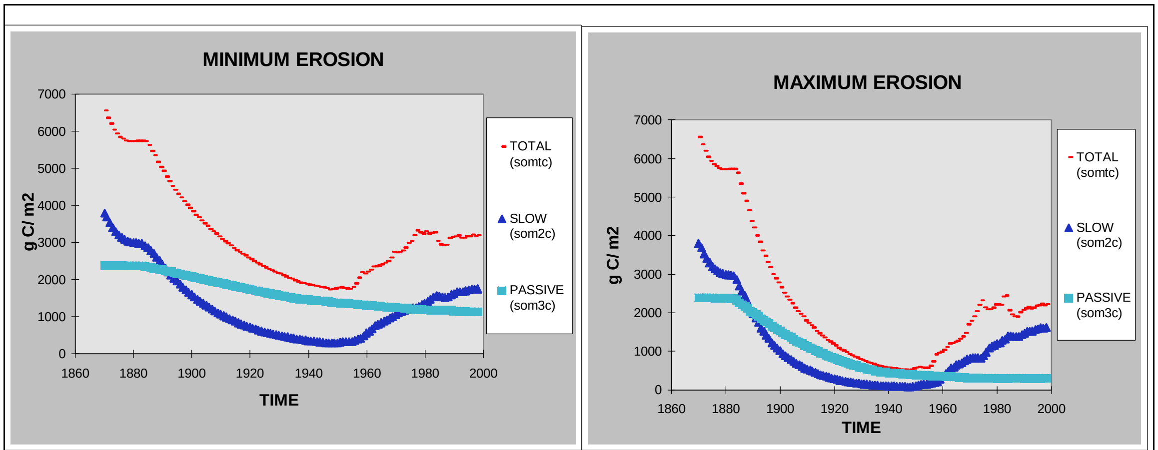
Figure 1. Estimates of Historic Soil Loss at Nelson Farm Based on Depth to Fragipan

For method, soil loss = (bulk density * horizon thickness summed to fragipan) for a control site MINUS (bulk density * horizon thicness to fragipan) for the upper slope at Nelson Farm.Two sets of control sites are used, a. an upper slope in a forested watershed at Goodwin Creek and b. a series of ridgetop sites.
For method 2, minimum and maximum estimates for sediment yields from T Soil Loss by Historic Sediment Yield

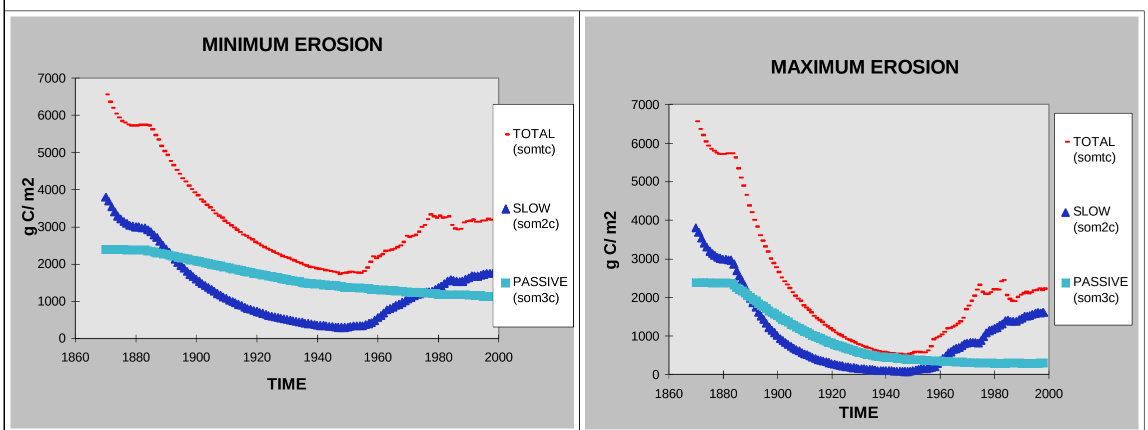


Because soil erosion is complexly related to many factors such as slope and management practices, a second check was made to compare with the sediment yields compiled from the literature. Soil mass above the fragipan at control sites was compared to that at the Nelson Farm upper slope (erosional) site.

Figure 2. Soil Organic Matter (0-20 cm) from Minimum and Maximum Erosion Schedules



****initial forest conditions, low carbon, ~3,446 gC/m2**



****initial forest conditions, high carbon, ~6,660 gC/m2**

Fig. 3 Total N in SOM (somte(1) and Residue Amounts (clittr(1,1)+clittr(2,1))

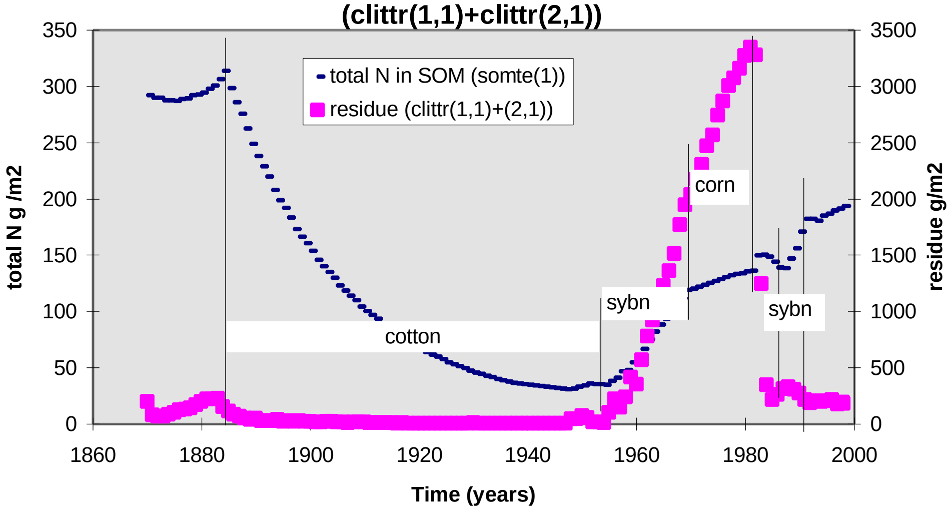
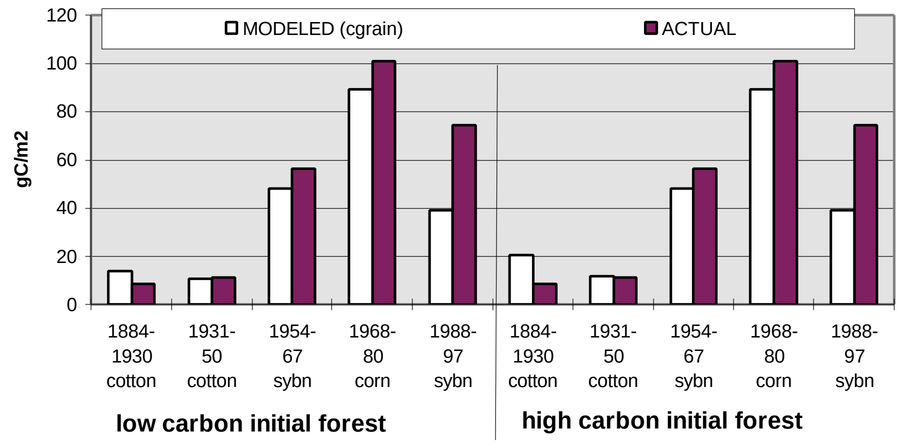


Fig. 4 Nelson Farm Crop Yields (Modeled vs. Actual)



note: grain yields from maximum schedule file, Missmx.

APPENDIX A *

SCHEDULE FILES

Missmn.sch (minimum erosion)

```
1870          Starting year
1997          Last year
Nelson.100          Site file name
0            Labeling type
-1           Labeling year
-1.00        Microcosm
-1           CO2 Systems
2            Initial system
             Initial crop
CWT          Initial tree

Year Month Option
1            Block #   stoch
1870         Last year
1            Repeats # years
1870         Output starting year
12           Output month
1.000        Output interval
S            Weather choice
  1   1 EROD
    0.0025
  1   2 EROD
    0.0025
  1   3 EROD
    0.0025
  1   4 EROD
    0.0025
  1   5 EROD
    0.0025
  1   5 TREE
CWT
  1   5 TFST
  1   6 EROD
    0.0025
  1   7 EROD
    0.0025
  1   8 EROD
    0.0025
  1   9 EROD
    0.0025
  1  10 EROD
    0.0025
  1  10 TLST
  1  11 EROD
```

Missmx.sch (maximum erosion)

```
1870          Starting year
1997          Last year
Nelson.100          Site file name
0            Labeling type
-1           Labeling year
-1.00        Microcosm
-1           CO2 Systems
2            Initial system
             Initial crop
CWT          Initial tree

Year Month Option
1            Block #   stoch
1870         Last year
1            Repeats # years
1870         Output starting year
12           Output month
1.000        Output interval
S            Weather choice
  1   1 EROD
      0.002
  1   2 EROD
      0.002
  1   3 EROD
      0.002
  1   4 EROD
      0.002
  1   5 EROD
      0.002
  1   5 TREE
CWT
  1   5 TFST
  1   6 EROD
      0.002
  1   7 EROD
      0.002
  1   8 EROD
      0.002
  1   9 EROD
      0.002
  1  10 EROD
      0.002
  1  10 TLST
  1  11 EROD
```

```
   0.0025
  1   12 EROD
   0.0025
-999 -999 X
2          Block #   stoch
1871        Last year
1          Repeats # years
1871        Output starting year
12          Output month
1.000       Output interval
S          Weather choice
  1    1 EROD
   0.0025
  1    2 EROD
   0.0025
  1    3 EROD
   0.0025
  1    3 TREM
NULL
  1    3 TFST
  1    3 TLST
  1    4 CULT
AT-7
  1    4 EROD
   0.0025
  1    5 EROD
   0.0025
  1    5 CROP
GGCP
  1    5 PLTM
  1    5 FRST
  1    6 EROD
   0.0025
  1    7 EROD
   0.0025
  1    8 EROD
   0.0025
  1   10 EROD
   0.0025
  1   10 SENM
  1   10 LAST
  1   11 EROD
   0.0025
  1   12 EROD
   0.0025
-999 -999 X
3          Block #   stoch
1882        Last year
1          Repeats # years
1872        Output starting year
12          Output month
1.000       Output interval
S          Weather choice
```

```
     0.002
  1   12 EROD
     0.002
-999 -999 X
2          Block #   stoch
1871        Last year
1          Repeats # years
1871        Output starting year
12          Output month
1.000       Output interval
S          Weather choice
  1    1 EROD
     0.002
  1    2 EROD
     0.002
  1    3 EROD
     0.002
  1    3 TREM
NULL
  1    3 TFST
  1    3 TLST
  1    4 CULT
AT-7
  1    4 EROD
     0.002
  1    5 EROD
     0.002
  1    5 CROP
GGCP
  1    5 PLTM
  1    5 FRST
  1    6 EROD
     0.002
  1    7 EROD
     0.002
  1    8 EROD
     0.002
  1   10 EROD
     0.002
  1   10 SENM
  1   10 LAST
  1   11 EROD
     0.002
  1   12 EROD
     0.002
-999 -999 X
3          Block #   stoch
1882        Last year
1          Repeats # years
1872        Output starting year
12          Output month
1.000       Output interval
S          Weather choice
```

```
  1    1 EROD
      0.006
  1    2 EROD
      0.006
  1    3 EROD
      0.006
  1    4 EROD
      0.006
  1    4 CROP
GGCP
  1    4 FRST
  1    5 EROD
      0.006
  1    6 EROD
      0.006
  1    7 EROD
      0.006
  1    8 EROD
      0.006
  1    9 EROD
      0.006
  1   10 EROD
      0.006
  1   10 SENM
  1   10 LAST
  1   11 EROD
      0.006
  1   12 EROD
      0.006
-999 -999 X
4          Block # actual wth
1929         Last year
4          Repeats # years
1883         Output starting year
12          Output month
1.000        Output interval
S          Weather choice
  1    1 EROD
       0.12
  1    2 EROD
       0.12
  1    3 EROD
       2.48
  1    3 CULT
AT-7
  1    4 EROD
       0.12
  1    4 CROP
COT
  1    4 PLTM
  1    4 FRST
  1    5 EROD
       0.12
```

```
  1    1 EROD
      0.014
  1    2 EROD
      0.014
  1    3 EROD
      0.014
  1    4 EROD
      0.014
  1    4 CROP
GGCP
  1    4 FRST
  1    5 EROD
      0.014
  1    6 EROD
      0.014
  1    7 EROD
      0.014
  1    8 EROD
      0.014
  1    9 EROD
      0.014
  1   10 EROD
      0.014
  1   10 SENM
  1   10 LAST
  1   11 EROD
      0.014
  1   12 EROD
      0.014
-999 -999 X
4          Block # actual wth
1929         Last year
4          Repeats # years
1883         Output starting year
12          Output month
1.000        Output interval
S          Weather choice
  1    1 EROD
       0.39
  1    2 EROD
       0.39
  1    3 EROD
       6.38
  1    3 CULT
AT-7
  1    4 EROD
       0.39
  1    4 CROP
COT
  1    4 PLTM
  1    4 FRST
  1    5 EROD
       0.39
```

1 6 EROD
0.12
1 7 EROD
0.12
1 8 EROD
0.12
1 9 EROD
0.12
1 9 SENM
1 9 HARV
GS
1 9 LAST
1 10 EROD
0.12
1 11 EROD
0.12
1 12 EROD
0.12
2 1 EROD
0.12
2 2 EROD
0.12
2 3 EROD
2.48
2 3 CULT
AT-7
2 4 EROD
0.12
2 4 CROP
COT
2 4 PLTM
2 4 FRST
2 5 EROD
0.12
2 6 EROD
0.12
2 7 EROD
0.12
2 8 EROD
0.12
2 9 EROD
0.12
2 9 SENM
2 9 HARV
GS
2 9 LAST
2 10 EROD
0.12
2 11 EROD
0.12
2 12 EROD
0.12
3 1 EROD

1 6 EROD
0.39
1 7 EROD
0.39
1 8 EROD
0.39
1 9 EROD
0.39
1 9 SENM
1 9 HARV
GS
1 9 LAST
1 10 EROD
0.39
1 11 EROD
0.39
1 12 EROD
0.39
2 1 EROD
0.62
2 2 EROD
0.62
2 3 EROD
10.23
2 3 CULT
AT-7
2 4 EROD
0.62
2 4 CROP
COT
2 4 PLTM
2 4 FRST
2 5 EROD
0.62
2 6 EROD
0.62
2 7 EROD
0.62
2 8 EROD
0.62
2 9 EROD
0.62
2 9 SENM
2 9 HARV
GS
2 9 LAST
2 10 EROD
0.62
2 11 EROD
0.62
2 12 EROD
0.62
3 1 EROD

0.12
3 2 EROD
0.12
3 3 EROD
2.48
3 3 CULT
AT-7
3 4 EROD
0.12
3 4 CROP
COT
3 4 PLTM
3 4 FRST
3 5 EROD
0.12
3 6 EROD
0.12
3 7 EROD
0.12
3 8 EROD
0.12
3 9 EROD
0.12
3 9 SENM
3 9 HARV
GS
3 9 LAST
3 10 EROD
0.12
3 11 EROD
0.12
3 12 EROD
0.12
4 1 EROD
0.12
4 2 EROD
0.12
4 3 EROD
2.48
4 3 CULT
AT-7
4 4 EROD
0.12
4 4 CROP
COT
4 4 PLTM
4 4 FRST
4 5 EROD
0.12
4 6 EROD
0.12
4 7 EROD
0.12

0.39
3 2 EROD
0.39
3 3 EROD
6.38
3 3 CULT
AT-7
3 4 EROD
0.39
3 4 CROP
COT
3 4 PLTM
3 4 FRST
3 5 EROD
0.39
3 6 EROD
0.39
3 7 EROD
0.39
3 8 EROD
0.39
3 9 EROD
0.39
3 9 SENM
3 9 HARV
GS
3 9 LAST
3 10 EROD
0.39
3 11 EROD
0.39
3 12 EROD
0.39
4 1 EROD
0.39
4 2 EROD
0.39
4 3 EROD
6.38
4 3 CULT
AT-7
4 4 EROD
0.39
4 4 CROP
COT
4 4 PLTM
4 4 FRST
4 5 EROD
0.39
4 6 EROD
0.39
4 7 EROD
0.39

```
  4   8 EROD
       0.12
  4   9 EROD
       0.12
  4   9 SENM
  4   9 HARV
GS
  4   9 LAST
  4  10 EROD
       0.12
  4  11 EROD
       0.12
  4  12 EROD
       0.12
-999 -999 X
5           Block #   actual wth
1936          Last year
1           Repeats # years
1930          Output starting year
12           Output month
1.000         Output interval
F           Weather choice
NFwth2.prn
  1   1 EROD
       0.12
  1   2 EROD
       0.12
  1   3 EROD
       2.48
  1   3 CULT
AT-7
  1   4 CROP
COT
  1   4 PLTM
  1   4 EROD
       0.12
  1   4 FRST
  1   4 FERT
N3
  1   4 FERT
PS2
  1   5 FERT
N3
  1   5 FERT
PS2
  1   5 EROD
       0.12
  1   6 EROD
       0.12
  1   6 FERT
N3
  1   6 FERT
PS2
```

```
  4   8 EROD
       0.39
  4   9 EROD
       0.39
  4   9 SENM
  4   9 HARV
GS
  4   9 LAST
  4  10 EROD
       0.39
  4  11 EROD
       0.39
  4  12 EROD
       0.39
-999 -999 X
5           Block #   actual wth
1936          Last year
1           Repeats # years
1930          Output starting year
12           Output month
1.000         Output interval
F           Weather choice
NFwth2.prn
  1   1 EROD
       0.39
  1   2 EROD
       0.39
  1   3 EROD
       6.38
  1   3 CULT
AT-7
  1   4 CROP
COT
  1   4 PLTM
  1   4 EROD
       0.39
  1   4 FRST
  1   4 FERT
N3
  1   4 FERT
PS2
  1   5 FERT
N3
  1   5 FERT
PS2
  1   5 EROD
       0.39
  1   6 EROD
       0.39
  1   6 FERT
N3
  1   6 FERT
PS2
```

```
  1    7 EROD
        0.12
  1    8 EROD
        0.12
  1    9 EROD
        0.12
  1    9 SENM
  1   10 HARV
GS
  1   10 EROD
        0.12
  1   10 LAST
  1   11 EROD
        0.12
  1   12 EROD
        0.12
-999 -999 X
6           Block #   actual wth
1945          Last year
1           Repeats # years
1937          Output starting year
12           Output month
1.000         Output interval
C            Weather choice
  1    1 EROD
        0.04
  1    2 EROD
        0.04
  1    3 EROD
        0.67
  1    3 CULT
AT-7
  1    4 EROD
        0.04
  1    4 CROP
COT
  1    4 PLTM
  1    4 FERT
N3
  1    4 FERT
PS2
  1    4 FRST
  1    5 EROD
        0.04
  1    5 FERT
N3
  1    5 FERT
PS2
  1    6 EROD
        0.04
  1    7 EROD
        0.04
  1    8 EROD
```

```
  1    7 EROD
        0.39
  1    8 EROD
        0.39
  1    9 EROD
        0.39
  1    9 SENM
  1   10 HARV
GS
  1   10 EROD
        0.39
  1   10 LAST
  1   11 EROD
        0.39
  1   12 EROD
        0.39
-999 -999 X
6           Block #   actual wth
1945          Last year
1           Repeats # years
1937          Output starting year
12           Output month
1.000         Output interval
C            Weather choice
  1    1 EROD
        0.16
  1    2 EROD
        0.16
  1    3 EROD
        2.64
  1    3 CULT
AT-7
  1    4 EROD
        0.16
  1    4 CROP
COT
  1    4 PLTM
  1    4 FERT
N3
  1    4 FERT
PS2
  1    4 FRST
  1    5 EROD
        0.16
  1    5 FERT
N3
  1    5 FERT
PS2
  1    6 EROD
        0.16
  1    7 EROD
        0.16
  1    8 EROD
```

```
       0.04
  1    9 EROD
       0.04
  1    9 SENM
  1   10 EROD
       0.04
  1   10 HARV
GS
  1   10 LAST
  1   11 EROD
       0.04
  1   12 EROD
       0.04
-999 -999 X
7          Block #   actual wth
1946         Last year
1          Repeats # years
1946         Output starting year
12          Output month
1.000        Output interval
C           Weather choice
  1    1 EROD
       0.31
  1    2 EROD
       0.31
  1    3 EROD
       0.31
  1    3 CULT
AT-7
  1    4 EROD
       5.18
  1    4 FERT
N3
  1    4 FERT
PS2
  1    4 CROP
COT
  1    4 PLTM
  1    4 FRST
  1    5 EROD
       0.31
  1    5 FERT
N3
  1    5 FERT
PS2
  1    6 EROD
       0.31
  1    7 EROD
       0.31
  1    8 EROD
       0.31
  1    9 EROD
       0.31
```

```
       0.16
  1    9 EROD
       0.16
  1    9 SENM
  1   10 EROD
       0.16
  1   10 HARV
GS
  1   10 LAST
  1   11 EROD
       0.16
  1   12 EROD
       0.16
-999 -999 X
7          Block #   actual wth
1946         Last year
1          Repeats # years
1946         Output starting year
12          Output month
1.000        Output interval
C           Weather choice
  1    1 EROD
       0.31
  1    2 EROD
       0.31
  1    3 EROD
       0.31
  1    3 CULT
AT-7
  1    4 EROD
       5.18
  1    4 FERT
N3
  1    4 FERT
PS2
  1    4 CROP
COT
  1    4 PLTM
  1    4 FRST
  1    5 EROD
       0.31
  1    5 FERT
N3
  1    5 FERT
PS2
  1    6 EROD
       0.31
  1    7 EROD
       0.31
  1    8 EROD
       0.31
  1    9 EROD
       0.31
```

```
  1    9 SENM
  1   10 EROD
        0.31
  1   10 HARV
GS
  1   10 LAST
  1   11 EROD
        0.31
  1   12 EROD
        0.31
-999 -999 X
8            Block #   actual wth
1950          Last year
1            Repeats # years
1947          Output starting year
12            Output month
1.000         Output interval
C             Weather choice
  1    1 EROD
        0.04
  1    2 EROD
        0.04
  1    3 EROD
        0.67
  1    3 CULT
AT-7
  1    4 EROD
        0.04
  1    4 CROP
COT
  1    4 FERT
PS2
  1    4 FERT
N3
  1    4 PLTM
  1    4 FRST
  1    5 EROD
        0.04
  1    5 FERT
PS2
  1    5 FERT
N3
  1    6 EROD
        0.04
  1    7 EROD
        0.04
  1    8 EROD
        0.04
  1    9 EROD
        0.04
  1    9 SENM
  1   10 EROD
        0.04
```

```
  1    9 SENM
  1   10 EROD
        0.31
  1   10 HARV
GS
  1   10 LAST
  1   11 EROD
        0.31
  1   12 EROD
        0.31
-999 -999 X
8            Block #   actual wth
1950          Last year
1            Repeats # years
1947          Output starting year
12            Output month
1.000         Output interval
C             Weather choice
  1    1 EROD
        0.16
  1    2 EROD
        0.16
  1    3 EROD
        2.64
  1    3 CULT
AT-7
  1    4 EROD
        0.16
  1    4 CROP
COT
  1    4 FERT
PS2
  1    4 FERT
N3
  1    4 PLTM
  1    4 FRST
  1    5 EROD
        0.16
  1    5 FERT
PS2
  1    5 FERT
N3
  1    6 EROD
        0.16
  1    7 EROD
        0.16
  1    8 EROD
        0.16
  1    9 EROD
        0.16
  1    9 SENM
  1   10 EROD
        0.16
```

```
  1   10 HARV
GS
  1   10 LAST
  1   11 EROD
       0.04
  1   12 EROD
       0.04
-999 -999 X
9            Block #   actual wth
1953          Last year
1            Repeats # years
1951          Output starting year
12            Output month
1.000         Output interval
C             Weather choice
  1    1 EROD
       0.03
  1    2 EROD
       0.03
  1    3 EROD
       0.52
  1    3 CROP
SORG
  1    3 PLTM
  1    3 FRST
  1    3 CULT
P
  1    4 EROD
       0.03
  1    5 EROD
       0.03
  1    6 EROD
       0.03
  1    7 EROD
       0.03
  1    8 EROD
       0.03
  1    9 EROD
       0.03
  1   10 EROD
       0.03
  1   11 EROD
       0.03
  1   11 HARV
H
  1   11 LAST
  1   12 EROD
       0.03
-999 -999 X
10            Block #   actual wth
1967          Last year
1            Repeats # years
1954          Output starting year
```

```
  1   10 HARV
GS
  1   10 LAST
  1   11 EROD
       0.16
  1   12 EROD
       0.16
-999 -999 X
9            Block #   actual wth
1953          Last year
1            Repeats # years
1951          Output starting year
12            Output month
1.000         Output interval
C             Weather choice
  1    1 EROD
       0.03
  1    2 EROD
       0.03
  1    3 EROD
       0.52
  1    3 CROP
SORG
  1    3 PLTM
  1    3 FRST
  1    3 CULT
P
  1    4 EROD
       0.03
  1    5 EROD
       0.03
  1    6 EROD
       0.03
  1    7 EROD
       0.03
  1    8 EROD
       0.03
  1    9 EROD
       0.03
  1   10 EROD
       0.03
  1   11 EROD
       0.03
  1   11 HARV
H
  1   11 LAST
  1   12 EROD
       0.03
-999 -999 X
10            Block #   actual wth
1967          Last year
1            Repeats # years
1954          Output starting year
```

```
12          Output month
1.0000      Output interval
C           Weather choice
  1    1 EROD
       0.07
  1    2 EROD
       0.07
  1    3 EROD
       0.07
  1    4 EROD
       1.18
  1    4 CULT
P
  1    5 CROP
SYBN
  1    5 PLTM
  1    5 FRST
  1    5 EROD
       0.07
  1    5 FERT
PS2
  1    6 EROD
       0.07
  1    6 FERT
A90
  1    7 EROD
       0.07
  1    7 FERT
A90
  1    8 EROD
       0.07
  1    9 EROD
       0.07
  1    9 SENM
  1   10 EROD
       0.07
  1   10 HARV
G
  1   10 LAST
  1   11 EROD
       0.07
  1   12 EROD
       0.07
-999 -999 X
11          Block #   actual wth
1980        Last year
1           Repeats # years
1968        Output starting year
12          Output month
1.000       Output interval
C           Weather choice
  1    1 EROD
       0.05
```

```
12          Output month
1.0000      Output interval
C           Weather choice
  1    1 EROD
       0.16
  1    2 EROD
       0.16
  1    3 EROD
       0.16
  1    4 EROD
       2.64
  1    4 CULT
P
  1    5 CROP
SYBN
  1    5 PLTM
  1    5 FRST
  1    5 EROD
       0.16
  1    5 FERT
PS2
  1    6 EROD
       0.16
  1    6 FERT
A90
  1    7 EROD
       0.16
  1    7 FERT
A90
  1    8 EROD
       0.16
  1    9 EROD
       0.16
  1    9 SENM
  1   10 EROD
       0.16
  1   10 HARV
G
  1   10 LAST
  1   11 EROD
       0.16
  1   12 EROD
       0.16
-999 -999 X
11          Block #   actual wth
1980        Last year
1           Repeats # years
1968        Output starting year
12          Output month
1.000       Output interval
C           Weather choice
  1    1 EROD
       0.08
```

```
  1    2 EROD
        0.05
  1    3 EROD
        0.05
  1    4 EROD
        0.05
  1    5 EROD
        0.96
  1    5 CROP
C-HI
  1    5 FERT
MAX
  1    5 PLTM
  1    5 FRST
  1    5 CULT
P
  1    6 CULT
ROW
  1    6 EROD
        0.05
  1    6 FERT
MAX
  1    7 FERT
MAX
  1    7 EROD
        0.05
  1    7 CULT
ROW
  1    8 EROD
        0.05
  1    9 EROD
        0.05
  1    9 SENM
  1   10 HARV
GS
  1   10 LAST
  1   10 EROD
        0.05
  1   11 EROD
        0.05
  1   12 EROD
        0.05
-999 -999 X
12           Block #   actual wth
1983           Last year
3            Repeats # years
1981           Output starting year
12           Output month
1.000          Output interval
C            Weather choice
  1    1 EROD
      0.015
  1    2 EROD
```

```
  1    2 EROD
        0.08
  1    3 EROD
        0.08
  1    4 EROD
        0.08
  1    5 EROD
        1.27
  1    5 CROP
C-HI
  1    5 FERT
MAX
  1    5 PLTM
  1    5 FRST
  1    5 CULT
P
  1    6 CULT
ROW
  1    6 EROD
        0.08
  1    6 FERT
MAX
  1    7 FERT
MAX
  1    7 EROD
        0.08
  1    7 CULT
ROW
  1    8 EROD
        0.08
  1    9 EROD
        0.08
  1    9 SENM
  1   10 HARV
GS
  1   10 LAST
  1   10 EROD
        0.08
  1   11 EROD
        0.08
  1   12 EROD
        0.08
-999 -999 X
12           Block #   actual wth
1983           Last year
3            Repeats # years
1981           Output starting year
12           Output month
1.000          Output interval
C            Weather choice
  1    1 EROD
        0.03
  1    2 EROD
```

0.015
1 3 EROD
0.015
1 4 FERT
PS2
1 4 EROD
0.24
1 4 CROP
SYBN
1 4 FRST
1 4 PLTM
1 4 CULT
P
1 5 EROD
0.015
1 6 EROD
0.015
1 7 EROD
0.015
1 8 EROD
0.015
1 8 HARV
G
1 8 LAST
1 9 CULT
P
1 9 EROD
0.015
1 10 EROD
0.015
1 10 CROP
W3
1 10 PLTM
1 10 FRST
1 10 FERT
N3
1 11 EROD
0.015
1 12 EROD
0.015
2 1 EROD
0.02
2 2 EROD
0.02
2 3 EROD
0.02
2 4 EROD
0.02
2 5 EROD
0.02
2 6 EROD
0.02
2 6 HARV

0.03
1 3 EROD
0.03
1 4 FERT
PS2
1 4 EROD
0.43
1 4 CROP
SYBN
1 4 FRST
1 4 PLTM
1 4 CULT
P
1 5 EROD
0.03
1 6 EROD
0.03
1 7 EROD
0.03
1 8 EROD
0.03
1 8 HARV
G
1 8 LAST
1 9 CULT
P
1 9 EROD
0.03
1 10 EROD
0.03
1 10 CROP
W3
1 10 PLTM
1 10 FRST
1 10 FERT
N3
1 11 EROD
0.03
1 12 EROD
0.03
2 1 EROD
0.02
2 2 EROD
0.02
2 3 EROD
0.02
2 4 EROD
0.02
2 5 EROD
0.02
2 6 EROD
0.02
2 6 HARV

```
H
  2    6 LAST
  2    7 EROD
        0.02
  2    9 CULT
P
  2    8 EROD
        0.02
  2    9 EROD
        0.02
  2    9 PLTM
  2    9 CROP
W3
  2    9 FERT
N3
  2    9 FRST
  2   10 EROD
        0.02
  2   11 EROD
        0.02
  2   12 EROD
        0.02
  3    1 EROD
        0.02
  3    2 EROD
        0.02
  3    3 EROD
        0.02
  3    4 EROD
        0.02
  3    5 EROD
        0.02
  3    6 EROD
        0.02
  3    6 HARV
H
  3    6 LAST
  3    7 CULT
P
  3    7 EROD
        0.02
  3    8 EROD
        0.02
  3    9 EROD
        0.02
  3   10 EROD
        0.02
  3   11 EROD
        0.02
  3   12 EROD
        0.02
-999 -999 X
13          Block #   actual wth
```


```
H
  2    6 LAST
  2    7 EROD
        0.02
  2    9 CULT
P
  2    8 EROD
        0.02
  2    9 EROD
        0.02
  2    9 PLTM
  2    9 CROP
W3
  2    9 FERT
N3
  2    9 FRST
  2   10 EROD
        0.02
  2   11 EROD
        0.02
  2   12 EROD
        0.02
  3    1 EROD
        0.02
  3    2 EROD
        0.02
  3    3 EROD
        0.02
  3    4 EROD
        0.02
  3    5 EROD
        0.02
  3    6 EROD
        0.02
  3    6 HARV
H
  3    6 LAST
  3    7 CULT
P
  3    7 EROD
        0.02
  3    8 EROD
        0.02
  3    9 EROD
        0.02
  3   10 EROD
        0.02
  3   11 EROD
        0.02
  3   12 EROD
        0.02
-999 -999 X
13          Block #   actual wth
```

```
1986         Last year
1            Repeats # years
1984         Output starting year
12           Output month
1.000        Output interval
C            Weather choice
  1    1 EROD
       0.02
  1    2 EROD
       0.02
  1    3 EROD
       0.02
  1    4 EROD
       0.02
  1    4 CROP
G3
  1    4 PLTM
  1    4 FRST
  1    5 EROD
       0.02
  1    6 EROD
       0.02
  1    7 EROD
       0.02
  1    8 EROD
       0.02
  1    9 EROD
       0.02
  1   10 EROD
       0.02
  1   11 EROD
       0.02
  1   12 EROD
       0.02
  1   12 LAST
-999 -999 X
14           Block #   actual wth
1987         Last year
1            Repeats # years
1987         Output starting year
12           Output month
1.000        Output interval
C            Weather choice
  1    1 EROD
       0.02
  1    2 EROD
       0.02
  1    3 EROD
       0.02
  1    4 EROD
       0.02
  1    4 CROP
G3
```


```
1986         Last year
1            Repeats # years
1984         Output starting year
12           Output month
1.000        Output interval
C            Weather choice
  1    1 EROD
       0.02
  1    2 EROD
       0.02
  1    3 EROD
       0.02
  1    4 EROD
       0.02
  1    4 CROP
G3
  1    4 PLTM
  1    4 FRST
  1    5 EROD
       0.02
  1    6 EROD
       0.02
  1    7 EROD
       0.02
  1    8 EROD
       0.02
  1    9 EROD
       0.02
  1   10 EROD
       0.02
  1   11 EROD
       0.02
  1   12 EROD
       0.02
  1   12 LAST
-999 -999 X
14           Block #   actual wth
1987         Last year
1            Repeats # years
1987         Output starting year
12           Output month
1.000        Output interval
C            Weather choice
  1    1 EROD
       0.02
  1    2 EROD
       0.02
  1    3 EROD
       0.02
  1    4 EROD
       0.02
  1    4 CROP
G3
```

```
  1   4 PLTM
  1   4 FRST
  1   5 EROD
       0.02
  1   6 EROD
       0.02
  1   7 EROD
       0.02
  1   7 CULT
H
  1   7 FIRE
H
  1   8 EROD
       0.02
  1   9 EROD
       0.02
  1  10 EROD
       0.02
  1  10 CULT
C
  1  10 CULT
P
  1  11 EROD
       0.02
  1  11 CROP
W3
  1  11 PLTM
  1  11 FRST
  1  11 CULT
R
  1  12 EROD
       0.02
  1  12 LAST
-999 -999 X
15          Block #   actual wth
1988          Last year
1           Repeats # years
1988          Output starting year
1           Output month
1.000         Output interval
C             Weather choice
  1   1 EROD
     0.025
  1   2 EROD
    0.0427
  1   3 EROD
    0.0427
  1   3 HARV
MOW-2
  1   3 CULT
P
  1   4 CROP
SYBN
```


```
  1   4 PLTM
  1   4 FRST
  1   5 EROD
       0.02
  1   6 EROD
       0.02
  1   7 EROD
       0.02
  1   7 CULT
H
  1   7 FIRE
H
  1   8 EROD
       0.02
  1   9 EROD
       0.02
  1  10 EROD
       0.02
  1  10 CULT
C
  1  10 CULT
P
  1  11 EROD
       0.02
  1  11 CROP
W3
  1  11 PLTM
  1  11 FRST
  1  11 CULT
R
  1  12 EROD
       0.02
  1  12 LAST
-999 -999 X
15          Block #   actual wth
1988          Last year
1           Repeats # years
1988          Output starting year
1           Output month
1.000         Output interval
C             Weather choice
  1   1 EROD
     0.025
  1   2 EROD
    0.0427
  1   3 EROD
    0.0427
  1   3 HARV
MOW-2
  1   3 CULT
P
  1   4 CROP
SYBN
```

```
  1   4 PLTM
  1   4 FRST
  1   4 EROD
    0.1255
  1   5 EROD
          0.3
  1   5 CULT
ROW
  1   6 FERT
PS2
  1   6 EROD
        0.75
  1   7 EROD
        0.25
  1   7 CULT
C
  1   8 EROD
        0.04
  1   9 EROD
        0.04
  1   9 SENM
  1  10 LAST
  1  10 EROD
        0.04
  1  11 EROD
        0.04
  1  11 HARV
G
  1  12 EROD
        0.04
-999 -999 X
16              Block #   actual wth
1989            Last year
1               Repeats # years
1989            Output starting year
1               Output month
1.000           Output interval
C               Weather choice
  1   1 EROD
        0.16
  1   2 EROD
        0.16
  1   3 EROD
        0.16
  1   4 EROD
        0.16
  1   5 EROD
        0.16
  1   5 CULT
P
  1   5 CULT
H
  1   5 PLTM
```


```
  1   4 PLTM
  1   4 FRST
  1   4 EROD
    0.1255
  1   5 EROD
          0.3
  1   5 CULT
ROW
  1   6 FERT
PS2
  1   6 EROD
        0.75
  1   7 EROD
        0.25
  1   7 CULT
C
  1   8 EROD
        0.04
  1   9 EROD
        0.04
  1   9 SENM
  1  10 LAST
  1  10 EROD
        0.04
  1  11 EROD
        0.04
  1  11 HARV
G
  1  12 EROD
        0.04
-999 -999 X
16              Block #   actual wth
1989            Last year
1               Repeats # years
1989            Output starting year
1               Output month
1.000           Output interval
C               Weather choice
  1   1 EROD
        0.16
  1   2 EROD
        0.16
  1   3 EROD
        0.16
  1   4 EROD
        0.16
  1   5 EROD
        0.16
  1   5 CULT
P
  1   5 CULT
H
  1   5 PLTM
```

```
  1   5 CROP
SYBN
  1   5 FERT
PS2
  1   6 CULT
C
  1   6 EROD
        2.64
  1   7 EROD
        0.16
  1   7 CULT
C
  1   8 EROD
        0.16
  1   9 SENM
  1   9 EROD
        0.16
  1  10 HARV
G
  1  10 LAST
  1  10 EROD
        0.16
  1  11 EROD
        0.16
  1  12 EROD
        0.16
-999 -999 X
17           Block #   actual wth
1990           Last year
1            Repeat # years
1990           Output starting year
1            Output month
1.000          Output interval
C            Weather choice
  1   1 EROD
        0.04
  1   2 EROD
        0.04
  1   3 EROD
        0.04
  1   4 EROD
        0.04
  1   4 CULT
H
  1   4 CULT
P
  1   5 CULT
H
  1   5 CULT
P
  1   5 PLTM
  1   5 CROP
SYBN
```

```
  1   5 CROP
SYBN
  1   5 FERT
PS2
  1   6 CULT
C
  1   6 EROD
        2.64
  1   7 EROD
        0.16
  1   7 CULT
C
  1   8 EROD
        0.16
  1   9 SENM
  1   9 EROD
        0.16
  1  10 HARV
G
  1  10 LAST
  1  10 EROD
        0.16
  1  11 EROD
        0.16
  1  12 EROD
        0.16
-999 -999 X
17           Block #   actual wth
1990           Last year
1            Repeat # years
1990           Output starting year
1            Output month
1.000          Output interval
C            Weather choice
  1   1 EROD
        0.04
  1   2 EROD
        0.04
  1   3 EROD
        0.04
  1   4 EROD
        0.04
  1   4 CULT
H
  1   4 CULT
P
  1   5 CULT
H
  1   5 CULT
P
  1   5 PLTM
  1   5 CROP
SYBN
```

```
  1   5 EROD
        0.61
  1   6 FERT
PS2
  1   6 CULT
H
  1   6 CULT
C
  1   6 EROD
        0.04
  1   7 CULT
C
  1   7 EROD
        0.04
  1  10 HARV
G
  1  10 LAST
  1  10 EROD
        0.04
  1  11 EROD
        0.04
  1  12 EROD
        0.04
-999 -999 X
18            Block # actual wth
1991           Last year
1             Repeat # years
1991           Output starting year
1             Output month
1.000          Output interval
C             Weather choice
  1   1 EROD
        0.12
  1   2 EROD
        0.12
  1   3 EROD
        0.12
  1   4 EROD
        0.12
  1   5 EROD
        1.96
  1   5 CULT
H
  1   5 CULT
P
  1   5 CULT
S
  1   5 PLTM
  1   5 CROP
SYBN
  1   6 CULT
C
  1   6 EROD
```


```
  1   5 EROD
        0.61
  1   6 FERT
PS2
  1   6 CULT
H
  1   6 CULT
C
  1   6 EROD
        0.04
  1   7 CULT
C
  1   7 EROD
        0.04
  1  10 HARV
G
  1  10 LAST
  1  10 EROD
        0.04
  1  11 EROD
        0.04
  1  12 EROD
        0.04
-999 -999 X
18            Block # actual wth
1991           Last year
1             Repeat # years
1991           Output starting year
1             Output month
1.000          Output interval
C             Weather choice
  1   1 EROD
        0.12
  1   2 EROD
        0.12
  1   3 EROD
        0.12
  1   4 EROD
        0.12
  1   5 EROD
        1.96
  1   5 CULT
H
  1   5 CULT
P
  1   5 CULT
S
  1   5 PLTM
  1   5 CROP
SYBN
  1   6 CULT
C
  1   6 EROD
```

```
      0.12
  1   7 FERT
PS2
  1   7 EROD
      0.12
  1   8 EROD
      0.12
  1   9 EROD
      0.12
  1   9 SENM
  1  10 HARV
G
  1  10 LAST
  1  10 EROD
      0.12
  1  11 EROD
      0.12
  1  12 EROD
      0.12
-999 -999 X
19          Block #   actual wth
1992          Last year
1           Repeat # years
1992          Output starting year
1           Output month
1.000         Output interval
C           Weather choice
  1   1 EROD
      0.07
  1   2 EROD
      0.07
  1   3 EROD
      0.07
  1   4 EROD
      0.07
  1   4 CULT
H
  1   4 CULT
P
  1   5 CULT
P
  1   5 CULT
S
  1   5 EROD
      1.14
  1   5 PLTM
  1   5 CROP
SYBN
  1   5 FRST
  1   6 FERT
PS2
  1   6 CULT
H
```


```
      0.12
  1   7 FERT
PS2
  1   7 EROD
      0.12
  1   8 EROD
      0.12
  1   9 EROD
      0.12
  1   9 SENM
  1  10 HARV
G
  1  10 LAST
  1  10 EROD
      0.12
  1  11 EROD
      0.12
  1  12 EROD
      0.12
-999 -999 X
19          Block #   actual wth
1992          Last year
1           Repeat # years
1992          Output starting year
1           Output month
1.000         Output interval
C           Weather choice
  1   1 EROD
      0.07
  1   2 EROD
      0.07
  1   3 EROD
      0.07
  1   4 EROD
      0.07
  1   4 CULT
H
  1   4 CULT
P
  1   5 CULT
P
  1   5 CULT
S
  1   5 EROD
      1.14
  1   5 PLTM
  1   5 CROP
SYBN
  1   5 FRST
  1   6 FERT
PS2
  1   6 CULT
H
```

```
  1   6 CULT
C
  1   6 EROD
        0.07
  1   7 EROD
        0.07
  1   8 EROD
        0.07
  1   9 EROD
        0.07
  1   9 SENM
  1  10 HARV
G
  1  10 LAST
  1  11 EROD
        0.07
  1  12 EROD
        0.07
-999 -999 X
20             Block #   actual wth
1993           Last year
1              Repeat # years
1993           Output starting year
1              Output month
1.000          Output interval
C              Weather choice
  1   1 EROD
        0.02
  1   2 EROD
        0.02
  1   3 EROD
        0.02
  1   4 EROD
        0.02
  1   4 CULT
P
  1   5 FERT
A90
  1   5 CULT
P
  1   5 PLTM
  1   5 CROP
SYBN
  1   5 EROD
        0.02
  1   6 FERT
A90
  1   6 EROD
        0.02
  1   6 CULT
C
  1   7 FERT
A90
```

```
  1   6 CULT
C
  1   6 EROD
        0.07
  1   7 EROD
        0.07
  1   8 EROD
        0.07
  1   9 EROD
        0.07
  1   9 SENM
  1  10 HARV
G
  1  10 LAST
  1  11 EROD
        0.07
  1  12 EROD
        0.07
-999 -999 X
20             Block #   actual wth
1993           Last year
1              Repeat # years
1993           Output starting year
1              Output month
1.000          Output interval
C              Weather choice
  1   1 EROD
        0.02
  1   2 EROD
        0.02
  1   3 EROD
        0.02
  1   4 EROD
        0.02
  1   4 CULT
P
  1   5 FERT
A90
  1   5 CULT
P
  1   5 PLTM
  1   5 CROP
SYBN
  1   5 EROD
        0.02
  1   6 FERT
A90
  1   6 EROD
        0.02
  1   6 CULT
C
  1   7 FERT
A90
```

```
  1   8 EROD
        0.02
  1   9 EROD
        0.02
  1   9 SENM
  1  10 HARV
G
  1  10 LAST
  1  10 EROD
        0.02
  1  11 EROD
        0.02
  1  12 EROD
        0.02
-999 -999 X
21          Block #   actual wth
1994          Last year
1           Repeat # years
1994          Output starting year
1           Output month
1.000         Output interval
C           Weather choice
  1   1 EROD
        0.08
  1    2 EROD
        0.08
  1    3 EROD
        0.08
  1    3 CULT
P
  1    4 CULT
P
  1    4 FERT
A90
  1    4 EROD
        1.26
  1    5 CULT
P
  1    5 CROP
SYBN
  1    5 PLTM
  1    5 FRST
  1    5 EROD
        0.08
  1    5 CULT
H
  1    5 FERT
A90
  1    6 FERT
A90
  1    6 CULT
C
  1    6 EROD
```


```
  1   8 EROD
        0.02
  1   9 EROD
        0.02
  1   9 SENM
  1  10 HARV
G
  1  10 LAST
  1  10 EROD
        0.02
  1  11 EROD
        0.02
  1  12 EROD
        0.02
-999 -999 X
21          Block #   actual wth
1994          Last year
1           Repeat # years
1994          Output starting year
1           Output month
1.000         Output interval
C           Weather choice
  1   1 EROD
        0.08
  1    2 EROD
        0.08
  1    3 EROD
        0.08
  1    3 CULT
P
  1    4 CULT
P
  1    4 FERT
A90
  1    4 EROD
        1.26
  1    5 CULT
P
  1    5 CROP
SYBN
  1    5 PLTM
  1    5 FRST
  1    5 EROD
        0.08
  1    5 CULT
H
  1    5 FERT
A90
  1    6 FERT
A90
  1    6 CULT
C
  1    6 EROD
```

```
        0.08
   1    7 EROD
        0.08
   1    8 EROD
        0.08
   1    9 SENM
   1    9 EROD
        0.08
   1   10 EROD
        0.08
   1   10 HARV
G
   1   10 LAST
   1   11 EROD
        0.08
   1   12 EROD
        0.08
-999 -999 X
22              Block #   actual wth
1997            Last year
1               Repeat # years
1995            Output starting year
1               Output month
1.0000          Output interval
C               Weather choice
   1    1 EROD
        0.02
   1    2 EROD
        0.02
   1    3 EROD
        0.02
   1    3 CULT
P
   1    4 EROD
        0.02
   1    4 CULT
P
   1    5 PLTM
   1    5 CROP
SYBN
   1    5 FRST
   1    5 EROD
       0.384
   1    5 CULT
ROW
   1    5 FERT
A90
   1    6 FERT
A90
   1    6 EROD
        0.02
   1    6 CULT
C
```


```
        0.08
   1    7 EROD
        0.08
   1    8 EROD
        0.08
   1    9 SENM
   1    9 EROD
        0.08
   1   10 EROD
        0.08
   1   10 HARV
G
   1   10 LAST
   1   11 EROD
        0.08
   1   12 EROD
        0.08
-999 -999 X
22              Block #   actual wth
1997            Last year
1               Repeat # years
1995            Output starting year
1               Output month
1.0000          Output interval
C               Weather choice
   1    1 EROD
        0.02
   1    2 EROD
        0.02
   1    3 EROD
        0.02
   1    3 CULT
P
   1    4 EROD
        0.02
   1    4 CULT
P
   1    5 PLTM
   1    5 CROP
SYBN
   1    5 FRST
   1    5 EROD
       0.384
   1    5 CULT
ROW
   1    5 FERT
A90
   1    6 FERT
A90
   1    6 EROD
        0.02
   1    6 CULT
C
```

```
  1    7 FERT
A90
  1    7 EROD
        0.02
  1    8 EROD
        0.02
  1    9 SENM
  1    9 EROD
        0.02
  1   10 HARV
G
  1   10 LAST
  1   10 EROD
        0.02
  1   11 EROD
        0.02
  1   12 EROD
        0.02
-999 -999 X
```

```
  1    7 FERT
A90
  1    7 EROD
        0.02
  1    8 EROD
        0.02
  1    9 SENM
  1    9 EROD
        0.02
  1   10 HARV
G
  1   10 LAST
  1   10 EROD
        0.02
  1   11 EROD
        0.02
  1   12 EROD
        0.02
-999 -999 X
```

* for using schedule file, each column can be copied and pasted into Microsoft Excel and saved as a <.sch> file.

APPENDIX B

MODEL IMPLEMENTATION

Because Century uses several programs to parameterize, run, and download output from the model, we include here a "cheat sheet" for easy implemementation of Century v. 4.0.

Cribsheet for Using the Century Soil Organic Model Version 4.0

1. **Create a <site>.100 file** for the study area
   - a) Click on the **File.100** program
   - b) Choose **#12**
   - c) Enter the name of a pre-existing site file (preferably similar to your site area) and then change the name to coincide with the new site area.
   - d) Enter abbreviation and description of the site
   - e) Go through the menu of 7 sub-headings and enter the proper values for the initial parameters of the new site. **** Note: you don't have to do the first sub-heading (climate parameters), explained below...

Inserting the Weather Data for your Site

- aa) Create a **<site>.wth** file following the format set-up by Century. Use a previous weather file as an example.
- bb) Go into the **File.100** program
- cc) Choose **#13**
- dd) Enter your weather file (extension ".wth"); Century will extract the necessary statistical info and then ask for the .100 file to insert the Climate Parameters

Note:** A weather file can be edited in Excel or Word, however, it must be saved as a "Text only" file.

2. Create a **schedule file** (<site>.sch) using the **Event.100** Program
   - a) **Click** on the Event.100 Program
   - b) Enter the **<site>.100** file that was previously made for the site.
   - c) Go through the commands.
     - aa) The **microcosm** simulation refers to simulating the decomposition of a sample of litter taken from the site under constant T and moisture. You must initialize the nutrient ratios and lignin content as well as specify the temperature for the simulation.
     - bb) The **CO_2 effect** is used to simulate the effects on plants of increases in the atmospheric concentration of CO_2.
     - cc) For the **initial crop**, hit **<Enter>** to view the possible choices.

THE BLOCKS:

The blocks are blocks of years where certain events will occur in repeating sequences on a yearly basis, every other year, etc. The logic of the blocks is a linear sequence so the years must follow a sequential order. No loop can exist within another loop. For every "block", you initialize one year and designate the repeating sequence. The left-hand column abbreviations are the "events" which can take place in certain months of the year. The bottom-hand commands are to help the user create the block.

3. Now, you are ready to **Run** the Century Model........
   a). From Windows95, Goto the **Start Icon.**
   b). Goto **"RUN".**
   c). Type the path where the Century program is found followed by "-s" <schedulefilename.sch> <space> "-n" <space> <outputfilename.bin>

   For example: c:NewCentury\Century -s Merced.sch -n output.bin

Note**: all files necessary for Century must be in the same folder as the execution program

4. Converting the **Output** of Century to a Readable File using List.100
   a). Click on **List100**
   b). Enter the **<site>.bin** output file of Century.
   c). **Rename** the file and give it an Excel extension (.xls)
   d). Hit **<Enter>** twice to get the entire time period (longer simulations, ex:10,000 years must be truncated
   e). Enter the **Output Variables** that you want to see (ex: somtc)
   note: hit **<enter>** after each variable and then a final **<enter>** to exit the program

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